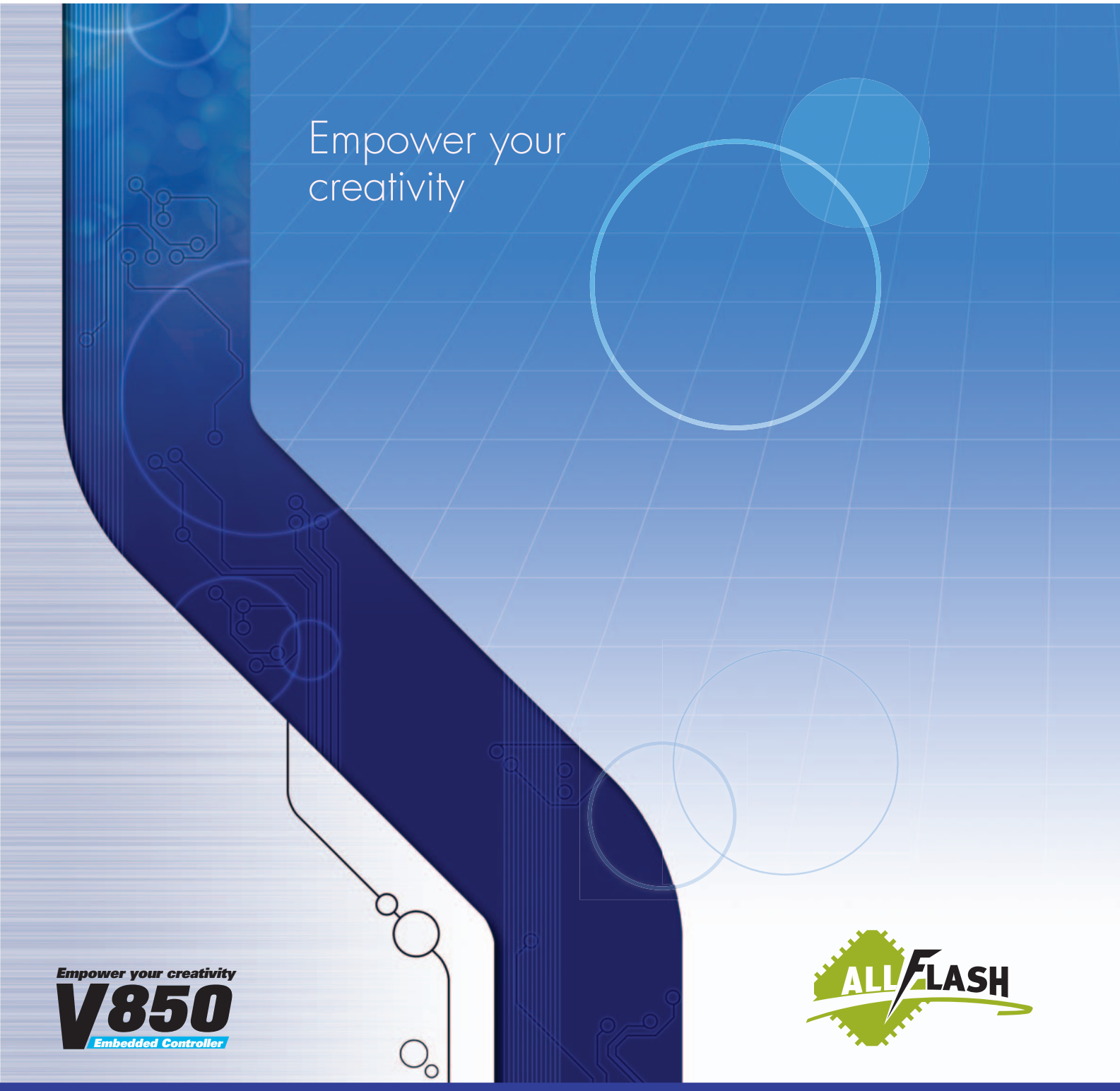
RENESAS

Renesas Microcomputer

32-bit All Flash

V850E, V850ES Microcontrollers



Renesas Electronics
www.renesas.com

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Flash

Shifting to All Flash

All of Renesas Electronics' 32-bit general-purpose microcontrollers are provided with on-chip flash memory.

Shifting to All Flash is bringing about a manufacturing revolution.

Shifting to All Flash means switching the entire lineup of microcontrollers offered by Renesas Electronics to flash memory products.
All Flash contributes to improved development efficiency, improved quality, and improved system competitiveness due to reduced costs.
V850 All Flash achieves 197MIPS (when operating at 100 MHz) and boasts an outstanding processing performance.
This outstanding performance is maintained across an extensive product lineup that includes the V850ES/Jx3-L, which consumes even less power than a 16-bit microcontroller; the V850ES/Jx3, which features a large-capacity ROM for future peace of mind; the V850ES/Jx3-U with an on-chip USB host controller; the V850E/Ix4 and V850E/Ix4-H, which include an inverter controller; and the V850ES/Jx3-E, which supports Ethernet.
User-friendly development environments that only users of All Flash microcontrollers can experience are also provided.
By offering a lineup of products and environment resources that allow full use of the merits of flash memory products, namely stock reduction, fast delivery, and flexible adaptation to fluctuations in demand, Renesas Electronics is helping to bring about a manufacturing revolution for customers.

ALL FLASH

H 5 V operation & on-chip multi-channel A/D converter

64-pin	80-pin	100-pin	144-pin
V850ES/HE3	V850ES/HF3	V850ES/HG3	V850ES/HJ3
V850ES/HE2	V850ES/HF2	V850ES/HG2	V850ES/HJ2

I 5 V inverter control support & on-chip A/D converter for simultaneous sampling of two circuits

64-pin	80-pin	100-/161-pin	128-pin
		V850E/IG4-H	V850E/IH4-H
		V850E/IG4	V850E/IH4
V850ES/IE2	V850E/IF3	V850E/IG3	

J 3 V operation & on-chip multi-channel serial interfaces: USB, CAN, Ethernet support

40-/48-pin	64-pin	80-pin	100-/113-/121-pin	128-pin	144-pin
			V850ES/JG3-E	V850ES/JH3-E	V850ES/JJ3-E
			V850ES/JG3-U	V850ES/JH3-U	
V850ES/JC3-H	V850ES/JE3-H		V850ES/JG3-H	V850ES/JH3-H	
			V850ES/JG3		V850ES/JJ3
			V850ES/JG2		V850ES/JJ2
V850ES/JC3-L	V850ES/JE3-L	V850ES/JF3-L	V850ES/JG3-L		

K Wide voltage support

64-pin	80-pin	100-pin	144-pin
V850ES/KE2	V850ES/KF2	V850ES/KG2	V850ES/KJ2

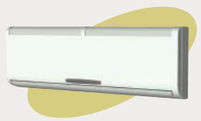
Application examples

All Flash microcontrollers are suitable for systems that use 16-bit microcontrollers and 32-bit microcontrollers, and add value to these systems.

Cameras
Digital still cameras, digital video cameras, SLR cameras

Industrial equipment
Industrial motors, control equipment, vending machines, power meters

Portable devices
PDAs, IC recorders



Home appliances
Air conditioners, refrigerators, washing machines, microwave ovens

Computer peripherals
LBP, PPC, MFP, inkjet printers, scanners, and fax machines

Video and recording equipment
Blu-ray players, Blu-ray recorders, industrial cameras

Audio
Portable audio, component stereo systems, home theater equipment

Other
Electronic instruments, electric bidets, toys, learning devices, remote controllers, etc.

Providing flash microcontrollers is one way that Renesas Electronics contributes to reforming the consumer supply chain.

Flash microcontrollers offer overwhelming advantages.

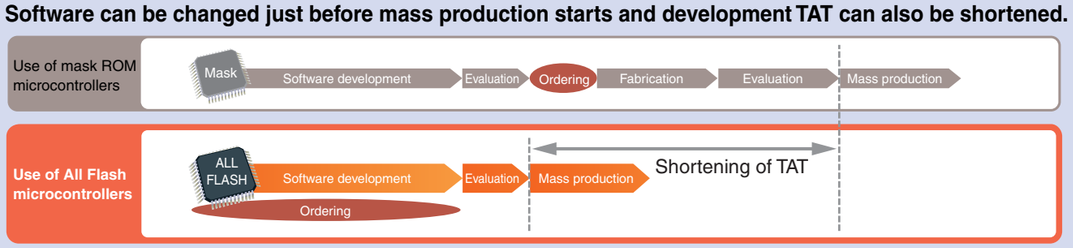
Compared to mask ROM microcontrollers, flash microcontrollers definitely contribute to speeding up system development. Microcontrollers can be ordered before program completion and programs can be written even after the microcontroller has been mounted on the board. Microcontroller order placement and program development can therefore be done concurrently, allowing TAT to be shortened as a result.

In addition, when flash microcontrollers are used for products with many different versions or that are localized for specific regions, the cost of ordering mask ROM microcontrollers is eliminated and purchase and stock management costs can be slashed.

For software designers

Software development | Hardware development | Ordering | Production

Software can be changed just before mass production starts and development TAT can also be shortened.

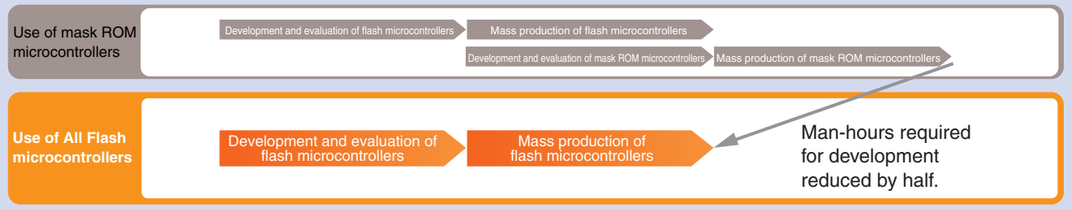


Since mask ROM microcontrollers cannot be ordered until their specifications are finalized, last-minute software changes can be problematic. On the other hand, specifications for flash microcontrollers can be changed just prior to the start of mass production. Thus orders for flash microcontrollers can be placed while the software is still being developed, allowing the development TAT to be shortened.

For hardware designers

Software development | Hardware development | Ordering | Production

Mass-produced flash microcontrollers require evaluation only once, reducing development man-hours.

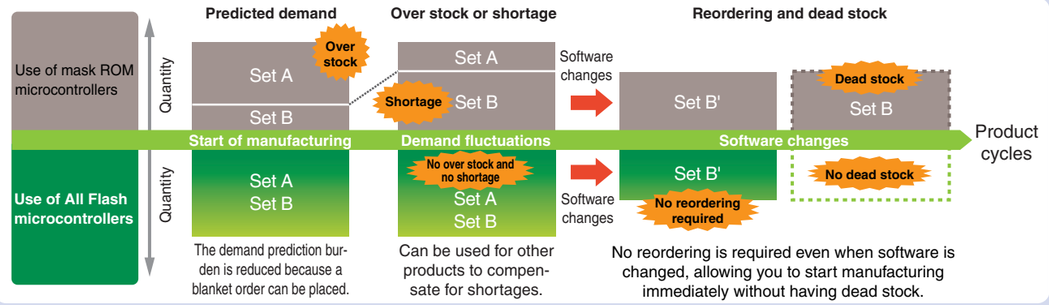

Use of mask ROM microcontrollers
Development and evaluation of flash microcontrollers
Mass production of flash microcontrollers
Development and evaluation of mask ROM microcontrollers
Mass production of mask ROM microcontrollers
Use of All Flash microcontrollers
Development and evaluation of flash microcontrollers
Mass production of flash microcontrollers
Man-hours required for development reduced by half.

In the case of mass-produced mask ROM microcontrollers, evaluations of both flash microcontrollers and mask ROM microcontrollers are required.
Since evaluated flash microcontrollers can be directly mass-produced, the man-hours required for development are reduced by half, resulting in greatly shortened development TAT.

For purchasing divisions

Software development | Hardware development | Ordering | Production

Flash microcontrollers protect you from fluctuations in demand and can reduce dead stock.

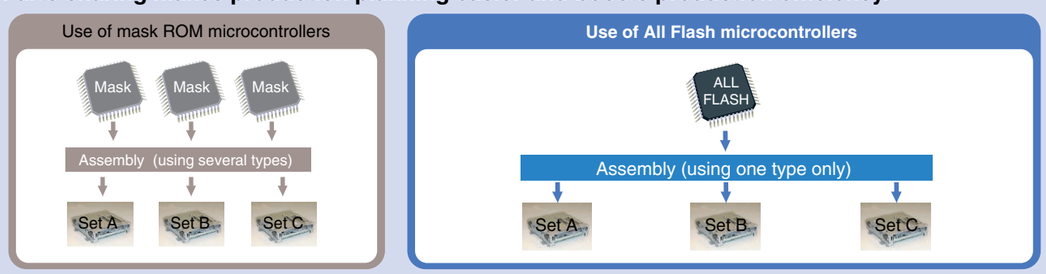


Mass-produced mask ROM microcontrollers may become dead stock as the result of changes in software or fluctuations in demand. On the other hand, flash microcontrollers can be mass-produced immediately after software changes and used for other products, resulting in fewer lost opportunities, less dead stock, and lower ordering costs.

For manufacturing divisions

Software development | Hardware development | Ordering | Production

Parts sharing makes production planning easier and boosts production efficiency.



In the case of mass-produced mask ROM microcontrollers, the use of different software for different products necessitates the use of a different microcontroller for each type of product. In contrast, mass-produced flash microcontrollers facilitate the sharing of parts since they can be used for various products by simply rewriting the software.

Worried about taking the first step? V850 All Flash puts you at ease.

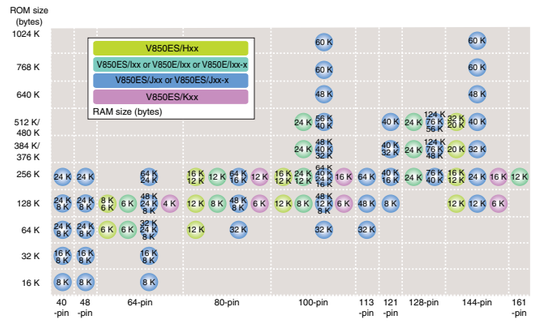
Use new products with confidence

For applications with large-scale programming and complicated systems, the development burden is heavy, so anxiety is even greater when it comes to using a new product. V850 All Flash eliminates the anxiety of using a new product, because Renesas Electronics reviews not only products themselves, but all other related aspects, including development, production, and distribution.

Large selection

179 models available

A total of 179 32-bit flash microcontroller models are available to meet all your needs.
With memories of from 16 to 1024 KB, and packages of 40 to 161 pins, the ideal product for your application can be selected from our extensive product lineup, according to the required voltage range or processing performance.
The 40-pin package is a thin and small WQFN just 6 mm x 6 mm in size and 0.75 mm thick. This package is approximately 46% thinner and 82% smaller than our conventional 32-bit microcontroller package (which is a 100-pin LQFP with a size of 14 mm x 14 mm), helping you reduce the size of your set.



Specialized lineup

Products ideally suited to specific applications

Renesas Electronics provides a range of products ideally suited to developing specific applications. These products include the V850ES/Jx3-H and V850ES/Jx3-U, which feature USB 2.0 communication capability and require only the internal ROM and RAM to develop applications requiring USB connectivity; the V850ES/Jx3-E, which includes an on-chip Ethernet controller enabling remote and monitoring control; and the V850E/Ix4 and V850E/Ix4-H, which feature a faster CPU—100 MHz—and fine-grained inverter control.

V850ES/Jx3-H, V850ES/Jx3-U
(portable POS terminals, printers, scanners)

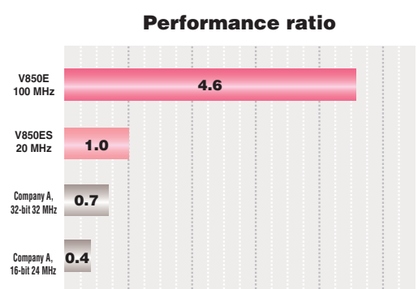
V850ES/Jx3-E
(factory automation equipment, building management systems)

V850E/Ix4, V850E/Ix4-H, V850E/Ix3
(inverter air conditioners)

High performance

Performance of 197MIPS @ 100 MHz

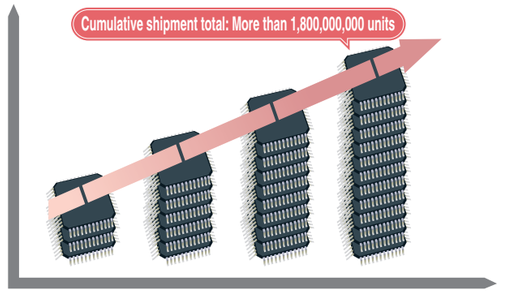
Our high-performance microcontrollers use a V850E core of 197MIPS @ 100 MHz. This performance enhances system functionality and reduces the time required for software tuning.
You can also reduce the number of components by integrating into a single microcontroller time-consuming processes that previously required two microcontrollers. You can also lower your power consumption by dropping the frequency.



High reliability

Software protection based on experience, technology and strong security features

All our products reflect the experience we have gained in supplying more than 1,8 billion microcontroller units (as of February, 2010) for more than 1,000 types of applications, and the technology we have developed for flash microcontrollers for the automotive field. Our products also provide features that disable reading and malicious software rewriting and erasing, thus offering maximum protection of your valuable software.



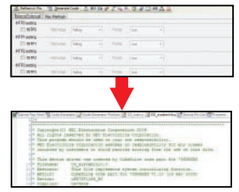
Supportive environment for development

We make development easier

Renesas Electronics has released the CubeSuite® integrated development platform, an easy-to-use and convenient development environment. CubeSuite can be used to compile and debug programs, manage pin layouts, generate code for microcontroller peripherals, and execute high-speed building.
Use CubeSuite in combination with MINICUBE2—an on-chip debug emulator with programming capability—to create a powerful environment that enables fast and accurate system development.

■ Top screen

■ Code generated easily

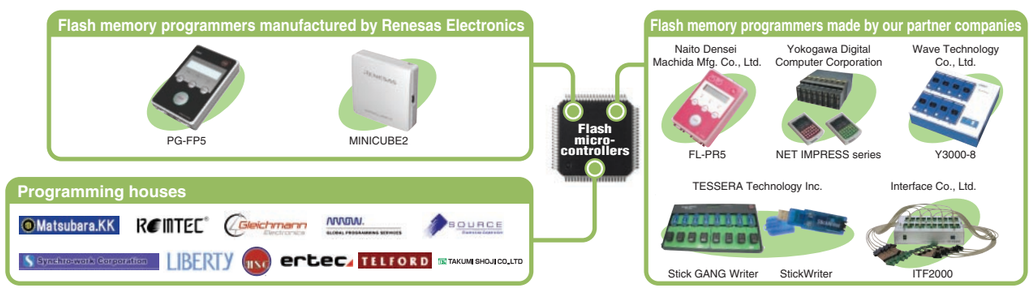


CubeSuite automatically generates source code (a device driver program) to control the microcontroller peripherals (such as the timers, UART, and A/D converter).

Mass production support

In addition to a full range of writing tools, writing services are also provided.

Numerous writing tools are provided not only by Renesas Electronics, but also by our partner companies, so programs can be easily written in nearly any situation, such as at development locations and on production lines. Furthermore, our partners, both overseas and in Japan, offer writing services for post-shipment mass-quantity writing and a wide variety of other needs.



Large selection (1/4)

We offer flash microcontrollers in various packages and ROM and RAM sizes, allowing you to select the best flash microcontroller for your product or application.

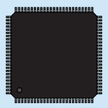
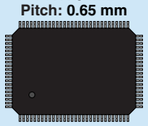
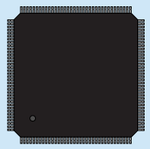
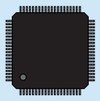
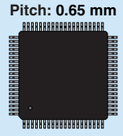
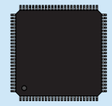
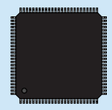
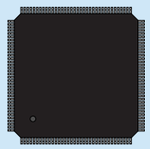
Generic Name	V850ES/HE2	V850ES/HF2	V850ES/HG2	V850ES/HJ2	V850ES/HE3	V850ES/HF3	V850ES/HG3	V850ES/HJ3	V850ES/IE2	V850E/IF3	V850E/IG3	V850E/IG4	V850E/IH4	V850E/IG4-H	V850E/IH4-H
Pin Count / ROM (Bytes)	64-pin	80-pin	100-pin	144-pin	64-pin	80-pin	100-pin	144-pin	64-pin	80-pin	100/161-pin	100-pin	128-pin	100-pin	128-pin
1024 K	Part Number (RAM: Bytes)														
768 K	V850ES/Hx2 Microcontrollers				V850ES/Hx3 Microcontrollers				V850ES/Ix2 and V850E/Ixx Microcontrollers for inverter control						
640 K															
512 K/ 480 K				µPD70F3712 (20 K)				µPD70F3757 (32 K)				µPD70F3915 (24 K)	µPD70F3918 (24 K)	µPD70F3921 (24 K)	µPD70F3924 (24 K)
384 K/ 376 K				µPD70F3711 (20 K)								µPD70F3914 (24 K)	µPD70F3917 (24 K)	µPD70F3920 (24 K)	µPD70F3923 (24 K)
256 K		µPD70F3704 (12 K)	µPD70F3707 (12 K)	µPD70F3710 (12 K)		µPD70F3750 (16 K)	µPD70F3752 (16 K)	µPD70F3755 (16 K)		µPD70F3452 (12 K)	µPD70F3454 (12 K)	µPD70F3913 (24 K)	µPD70F3916 (24 K)	µPD70F3919 (24 K)	µPD70F3922 (24 K)
128 K	µPD70F3701 (6 K)	µPD70F3703 (12 K)	µPD70F3706 (12 K)	µPD70F3709 (12 K)	µPD70F3747 (8 K)				µPD70F3714 (6 K)	µPD70F3451 (8 K)	µPD70F3453 (8 K)				
64 K	µPD70F3700 (6 K)	µPD70F3702 (12 K)							µPD70F3713 (6 K)						
32 K															
16 K															
Package	64-pin LQFP GB Thickness:1.4 mm 10 x 10 mm Pitch: 0.5 mm	80-pin TQFP GK Thickness:1.0 mm 12 x 12 mm Pitch: 0.5 mm	100-pin LQFP GC Thickness:1.4 mm 14 x 14 mm Pitch: 0.5 mm	144-pin LQFP GJ Thickness: 1.4 mm 20 x 20 mm Pitch: 0.5 mm	64-pin LQFP GB Thickness: 1.4 mm 10 x 10 mm Pitch: 0.5 mm	80-pin LQFP GK Thickness:1.4 mm 12 x 12 mm Pitch: 0.5 mm	100-pin LQFP GC Thickness: 1.4 mm 14 x 14 mm Pitch: 0.5 mm	144-pin LQFP GJ Thickness: 1.4 mm 20 x 20 mm Pitch: 0.5 mm	64-pin LQFP GC Thickness: 1.4 mm 14 x 14 mm Pitch: 0.8 mm	80-pin LQFP GC Thickness: 1.4 mm 14 x 14 mm Pitch: 0.65 mm	100-pin LQFP GC Thickness: 1.4 mm 14 x 14 mm Pitch: 0.5 mm 100-pin LQFP GF Thickness: 1.4 mm 14 x 20 mm Pitch: 0.65 mm 161-pin FBGA[Note] F1 Thickness: 1.13 mm 10 x 10 mm Pitch: 0.65 mm	100-pin LQFP GC Thickness: 1.4 mm 14 x 14 mm Pitch: 0.5 mm 100-pin LQFP GF Thickness: 1.4 mm 14 x 20 mm Pitch: 0.65 mm	128-pin LQFP GF Thickness: 1.4 mm 14 x 20 mm Pitch: 0.5 mm	100-pin LQFP GC Thickness: 1.4 mm 14 x 14 mm Pitch: 0.5 mm	128-pin LQFP GF Thickness: 1.4 mm 14 x 20 mm Pitch: 0.5 mm

Note µPD70F3454 only

Remark The packages shown are the actual size.

Large selection (2/4)

We offer flash microcontrollers in various packages and ROM and RAM sizes, allowing you to select the best flash microcontroller for your product or application.

Generic Name	V850ES/JG2	V850ES/JJ2	V850ES/JC3-L		V850ES/JE3-L	V850ES/JF3-L	V850ES/JG3-L	V850ES/JG3	V850ES/JJ3
Pin Count / ROM (Bytes)	100-pin	144-pin	40-pin	48-pin	64-pin	80-pin	100/121-pin	100-pin	144-pin
1024 K	Part Number (RAM: Bytes)							μPD70F3742 (60 K)	μPD70F3746 (60 K)
768 K								μPD70F3741 (60 K)	μPD70F3745 (60 K)
640 K	μPD70F3719 (48 K)	μPD70F3724 (48 K)		V850ES/Jx3-L Microcontrollers					
512 K/ 480 K	μPD70F3718 (40 K)	μPD70F3723 (40 K)					μPD70F3793[Note 1], μPD70F3796[Note 1] (40 K)	μPD70F3740 (40 K)	μPD70F3744 (40 K)
384 K/ 376 K	μPD70F3717 (32 K)	μPD70F3722 (32 K)					μPD70F3792[Note 1] (32 K), μPD70F3795[Note 1] (40 K)	μPD70F3739 (32 K)	μPD70F3743 (32 K)
256 K	μPD70F3716 (24 K)	μPD70F3721 (24 K)				μPD70F3736 (16 K)	μPD70F3738 (16 K), μPD70F3794[Note 1] (40 K)	V850ES/Jx3 Microcontrollers	
128 K	μPD70F3715 (12 K)	μPD70F3720 (12 K)	μPD70F3800[Note 1] (8 K)	μPD70F3804[Note 1] (8 K)	μPD70F3808[Note 1] (8 K)	μPD70F3735 (8 K)	μPD70F3737 (8 K)		
64 K	V850ES/Jx2 Microcontrollers		μPD70F3799[Note 1] (8 K)	μPD70F3803[Note 1] (8 K)	μPD70F3807[Note 1] (8 K)				
32 K			μPD70F3798[Note 1] (8 K)	μPD70F3802[Note 1] (8 K)	μPD70F3806[Note 1] (8 K)				
16 K			μPD70F3797[Note 1] (8 K)	μPD70F3801[Note 1] (8 K)	μPD70F3805[Note 1] (8 K)				
Package	100-pin LQFP GC Thickness: 1.4 mm 14 x 14 mm Pitch: 0.5 mm  100-pin QFP[Note 2] GF Thickness: 2.7 mm 14 x 20 mm Pitch: 0.65 mm 	144-pin LQFP GJ Thickness: 1.4 mm 20 x 20 mm Pitch: 0.5 mm 	40-pin WQFN K8 Thickness: 0.75 mm 6 x 6 mm Pitch: 0.5 mm	48-pin LQFP GA Thickness: 1.4 mm 7 x 7 mm Pitch: 0.5 mm 48-pin WQFN K8 Thickness: 0.75 mm 7 x 7 mm Pitch: 0.5 mm	64-pin LQFP GB Thickness: 1.4 mm 10 x 10 mm Pitch: 0.5 mm 64-pin FBGA F1 Thickness: 0.91 mm 5 x 5 mm Pitch: 0.5 mm 64-pin WQFN K8 Thickness: 0.75 mm 9 x 9 mm Pitch: 0.5 mm	80-pin LQFP GK Thickness:1.4 mm 12 x 12 mm Pitch: 0.5 mm  80-pin LQFP GC Thickness: 1.4 mm 14 x 14 mm Pitch: 0.65 mm 	100-pin LQFP GC Thickness:1.4 mm 14 x 14 mm Pitch: 0.5 mm  100-pin LQFP[Note 3] GF Thickness: 1.4 mm 14 x 20 mm Pitch: 0.65 mm 121-pin FBGA F1 Thickness: 1.21 mm 8 x 8 mm Pitch: 0.65 mm	100-pin LQFP GC Thickness: 1.4 mm 14 x 14 mm Pitch: 0.5 mm 	144-pin LQFP GJ Thickness: 1.4 mm 20 x 20 mm Pitch: 0.5 mm 

Notes 1. Under development
2. μPD70F3715, 70F3716, and 70F3717 only
3. μPD70F3737 and 70F3738 only

Remark The packages shown are the actual size.

Large selection (3/4)

We offer flash microcontrollers in various packages and ROM and RAM sizes, allowing you to select the best flash microcontroller for your product or application.

Generic Name	V850ES/JC3-H		V850ES/JE3-H	V850ES/JG3-H	V850ES/JH3-H	V850ES/JG3-U	V850ES/JH3-U	V850ES/JE3-E	V850ES/JF3-E	V850ES/JG3-E	V850ES/JH3-E	V850ES/JJ3-E
Pin Count / ROM (Bytes)	40-pin	48-pin	64-pin	100-pin	128-pin	100-pin	128-pin	64-pin	80-pin	100/113-pin	128-pin	144-pin
1024 K	Part Number (RAM: Bytes)											
768 K												
640 K												
512 K/ 480 K				μPD70F3762 (56 K[Note 2])	μPD70F3767 (56 K[Note 2])	μPD70F3764 (56 K[Note 2])	μPD70F3769 (56 K[Note 2])				μPD70F3780 (76 K[Note 3]), μPD70F3782, 70F3783 (124 K[Note 4])	μPD70F3784 (76 K[Note 3]), μPD70F3785, 70F3786 (124 K[Note 4])
384 K/ 376 K				μPD70F3761 (48 K[Note 2])	μPD70F3766 (48 K[Note 2])	μPD70F3763 (48 K[Note 2])	μPD70F3768 (48 K[Note 2])				μPD70F3779 (76 K[Note 3]), μPD70F3781 (124 K[Note 4])	
256 K	μPD70F3813[Note 1] (24 K)	μPD70F3818[Note 1], μPD70F3819[Note 1] (24 K)	μPD70F3824[Note 1], μPD70F3825[Note 1] (24 K)	μPD70F3760, μPD70F3770, (40 K[Note 2])	μPD70F3765, μPD70F3771, (40 K[Note 2])			μPD70F3828[Note 1], μPD70F3829[Note 1] (64 K[Note 3])	μPD70F3832[Note 1], μPD70F3833[Note 1] (64 K[Note 3])	μPD70F3836[Note 1], μPD70F3837[Note 1] (64 K[Note 3])	μPD70F3778 (76 K[Note 3])	
128 K	μPD70F3812[Note 1] (24 K)	μPD70F3817[Note 1] (24 K)	μPD70F3823[Note 1] (24 K)					μPD70F3827[Note 1] (48 K[Note 3])	μPD70F3831[Note 1] (48 K[Note 3])	μPD70F3835[Note 1] (48 K[Note 3])		
64 K	μPD70F3811[Note 1] (24 K)	μPD70F3816[Note 1] (24 K)	μPD70F3822[Note 1] (24 K)					μPD70F3826[Note 1] (32 K[Note 3])	μPD70F3830[Note 1] (32 K[Note 3])	μPD70F3834[Note 1] (32 K[Note 3])		
32 K	μPD70F3810[Note 1] (16 K)	μPD70F3815[Note 1] (16 K)	μPD70F3821[Note 1] (16 K)									
16 K	μPD70F3809[Note 1] (8 K)	μPD70F3814[Note 1] (8 K)	μPD70F3820[Note 1] (8 K)									
Package	40-pin WQFN K8 Thickness: 0.75 mm 6 x 6 mm Pitch: 0.5 mm	48-pin LQFP GA Thickness: 1.4 mm 7 x 7 mm Pitch: 0.5 mm 48-pin WQFN K8 Thickness: 0.75 mm 7 x 7 mm Pitch: 0.5 mm	64-pin LQFP GB Thickness: 1.4 mm 10 x 10 mm Pitch: 0.5 mm 64-pin FBGA[Note 5] F1 Thickness: 1.11 mm 6 x 6 mm Pitch: 0.65 mm 64-pin WQFN K8 Thickness: 0.75 mm 9 x 9 mm Pitch: 0.5 mm	100-pin LQFP GC Thickness: 1.4 mm 14 x 14 mm Pitch: 0.5 mm	128-pin LQFP GF Thickness: 1.4 mm 14 x 20 mm Pitch: 0.5 mm	100-pin LQFP GC Thickness: 1.4 mm 14 x 14 mm Pitch: 0.5 mm	128-pin LQFP GF Thickness: 1.4 mm 14 x 20 mm Pitch: 0.5 mm	64-pin LQFP GB Thickness: 1.4 mm 10 x 10 mm Pitch: 0.5 mm 64-pin WQFN K8 Thickness: 0.75 mm 9 x 9 mm Pitch: 0.5 mm	80-pin LQFP GK Thickness: 1.4 mm 12 x 12 mm Pitch: 0.5 mm	100-pin LQFP GC Thickness: 1.4 mm 14 x 14 mm Pitch: 0.5 mm 113-pin FBGA F1 Thickness: 0.91 mm 8 x 8 mm Pitch: 0.65 mm	128-pin LQFP GF Thickness: 1.4 mm 14 x 20 mm Pitch: 0.5 mm	144-pin LQFP GJ Thickness: 1.4 mm 20 x 20 mm Pitch: 0.5 mm

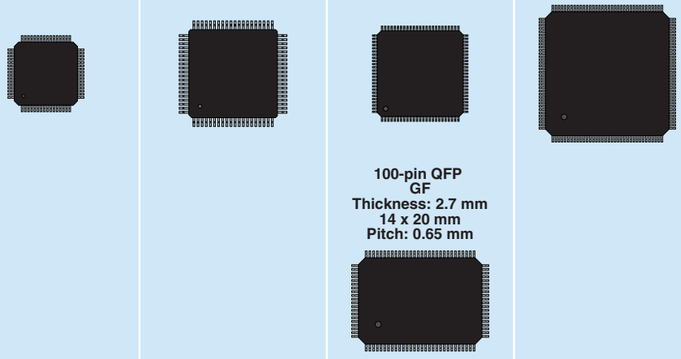
Notes 1. Under development
2. Contains an 8 KB area for data use only.
3. Contains a 16 KB area for data use only.
4. Contains a 64 KB area for data use only.
5. μPD70F3824 only

Remark The packages shown are the actual size.

Large selection (4/4)

We offer flash microcontrollers in various packages and ROM and RAM sizes, allowing you to select the best flash microcontroller for your product or application.

Generic Name	V850ES/KE2	V850ES/KF2	V850ES/KG2	V850ES/KJ2
Pin Count / ROM (Bytes)	64-pin	80-pin	100-pin	144-pin
1024 K	Part Number (RAM: Bytes)			
768 K				
640 K				
512 K/ 480 K	V850ES/Kx2 Microcontrollers			
384 K/ 376 K				
256 K		μPD70F3729 (12 K)	μPD70F3732 (16 K)	μPD70F3734 (16 K)
128 K	μPD70F3726 (4 K)	μPD70F3728 (6 K)	μPD70F3731 (6 K)	μPD70F3733 (6 K)
64 K				
32 K				
16 K				
Package	64-pin LQFP GB Thickness: 1.4 mm 10 x 10 mm Pitch: 0.5 mm	80-pin QFP GC Thickness: 1.4 mm 14 x 14 mm Pitch: 0.65 mm	100-pin LQFP GC Thickness: 1.4 mm 14 x 14 mm Pitch: 0.5 mm 100-pin QFP GF Thickness: 2.7 mm 14 x 20 mm Pitch: 0.65 mm	144-pin LQFP GJ Thickness: 1.4 mm 20 x 20 mm Pitch: 0.5 mm



Remark The packages shown are the actual size.

Specialized lineup (1/2)

We provide products ideally suited to specific applications.
With our extensive specialized lineup, you can choose the product that is perfect for your system.

USB microcontrollers (V850ES/Jx3-H, V850ES/Jx3-U)

1. Complete USB 2.0 functionality on a single chip

Applications that require USB connectivity can be developed quickly and easily because a USB 2.0 host[Note] and/or USB 2.0 function interface is integrated on the microcontroller chip, eliminating the need to connect an external USB chip.

■ **USB specifications**

- On-chip USB 2.0 host (full-speed) interface x 1 ch[Note]/USB 2.0 function (full-speed) interface x 1 ch
- USB host transfer modes[Note] : Control, Bulk, Interrupt, and Isochronous
- USB host interface connectivity[Note] : PPON (USB power supply output) pin
  OCI (overcurrent detection input) pin
- USB function interface endpoint configuration:
  Two endpoints for Control transfers, four endpoints for Bulk transfers, and one endpoint for Interrupt transfers

Note V850ES/Jx3-U only.

■ **All our USB microcontrollers are USB certified.**

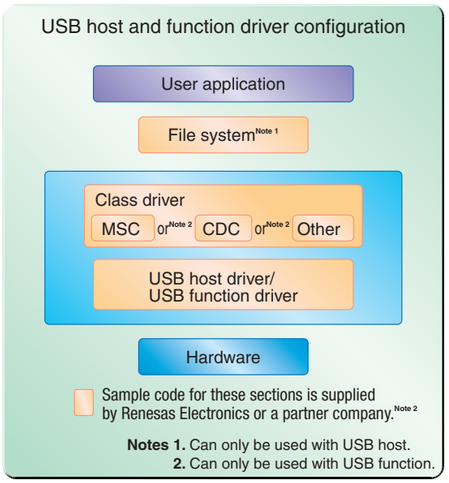
2. Extensive USB driver support

■ **USB drivers**

- USB function driver
  Renesas Electronics provides free sample code.
  Driver software is available from one of our partner companies.
- USB host driver
  Driver software is available from one of our partner companies.
  Partner companies : Interface Co., Ltd.
  Tepco Uquest, Ltd.
  Grape Systems Inc.
  Ubiquitous Corporation

Remark MSC: Mass storage class
CDC: Communication device class

USB host and function driver configuration



Notes 1. Can only be used with USB host.
2. Can only be used with USB function.

3. Supportive development environment

Renesas Electronics offers two starter kits: one for USB host system development, and one for USB function system development. These starter kits help you develop and evaluate your application at the system level.

TK-850/JH3U-SP
Made by TESSERA Technology Inc.

TK-850/JG3H
Made by TESSERA Technology Inc.

Specialized lineup (2/2)

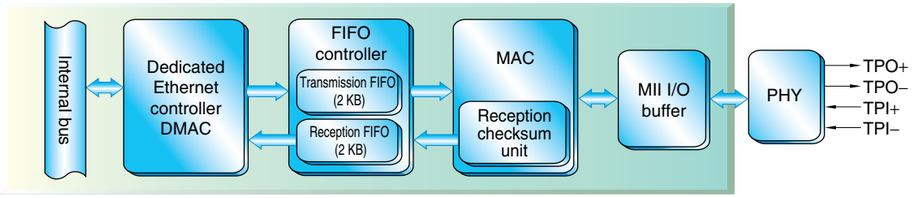
Ethernet microcontrollers (V850ES/Jx3-E)

1. Control your networks and systems using only the internal memory.

Renesas Electronics' Ethernet microcontrollers incorporate up to 512 KB of flash memory and 124 KB of RAM. They also include a 10/100 base Ethernet MAC and feature a high CPU performance of 103MIPS (Dhrystone 1.1) when operating at 50 MHz. This enables network and system control using only the internal memory.

2. On-chip Ethernet controller lets you build a low-cost system

- MAC
  - Enables IEEE802.3-compliant 10/100 Mbps full-duplex and half-duplex communication as well as flow control.
  - Uses MII as the physical layer device (PHY) interface.
  - Includes an on-chip VLAN detector.
- FIFO size: Transmission = 2 KB, Reception = 2 KB
- Dedicated Ethernet controller DMAC
- On-chip reception checksum calculator compliant with RFC1071

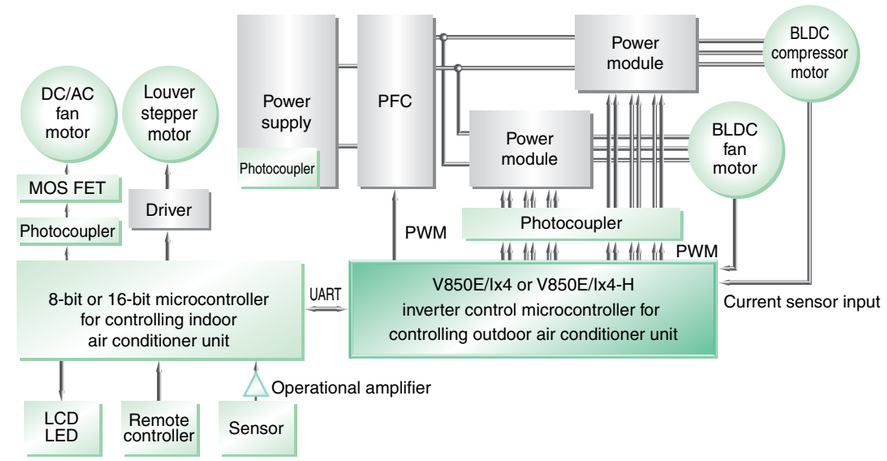


3. Enhanced development environment and network software

Renesas Electronics provides a starter kit that can be used for evaluation and development at the system level and network software. Network software is also available from our partner companies. See the Application Examples page for more details.

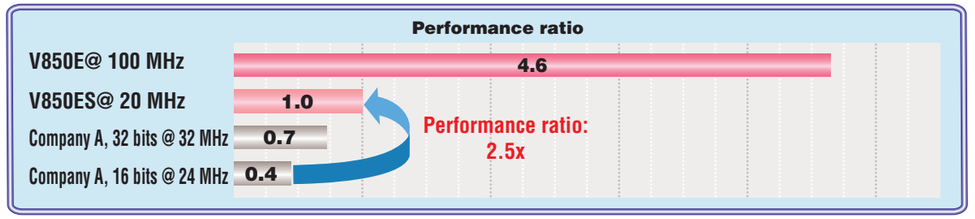
Inverter control microcontrollers (V850E/Ix4, V850E/Ix4-H)

The V850E/Ix4 and V850E/Ix4-H feature a CPU with a ramped up operating speed of 100 MHz—1.5 times faster than our previous model—enabling much finer inverter control.
Add this to the large-capacity internal flash memory (256 KB to up to 480 KB), and you have a microcontroller that is ideal for systems that need to run large-capacity programs, such as factory automation equipment. Our inverter control microcontrollers also have a wealth of built-in analog peripherals, including a 12-bit A/D converter, six operational amplifiers, and 12 comparators. This helps greatly to reduce the number of components in the system and reduce costs.

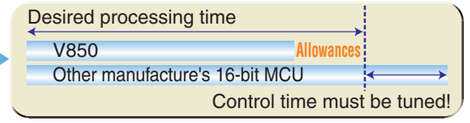


High performance

High performance of 197MIPS @ 100 MHz.
This performance goes far beyond simply enhancing your application functionality.



Reduction of development man-hours
You can reduce the time required for software tuning.



Thanks to this high performance, you no longer have to carry out the processing time tuning that had to be performed when using a conventional 16-bit microcontroller, allowing you to develop your software more efficiently.

Low power consumption
By dropping the frequency, you can lower the power consumptions.

Theoretically, a higher performance than a 16-bit MCU is gained with the frequency halved
1/2 frequency ≒ 1/2 power consumption

V850 can perform the same processing with a 16-bit microcontroller only with 1/2 to 1/3 of frequency, lowering the power consumption.

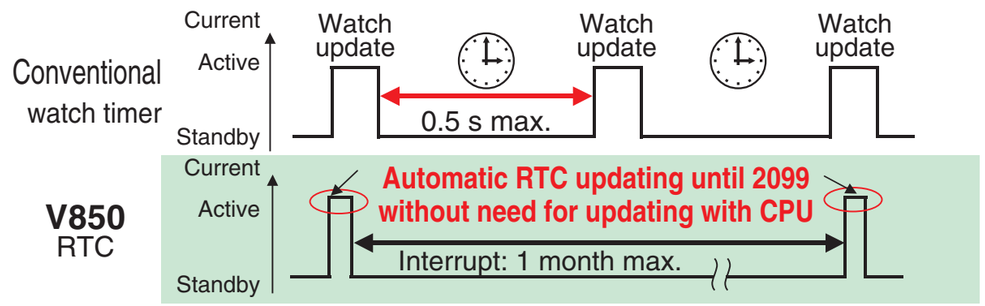
Reduction of total costs
You can reduce the number of components.

Computing capability is double or higher. Single V850 can perform the workloads of two or more microcontrollers, reducing the numbers of components
Workload of a single V850 ≥ 16-bit microcontroller × 2

Due to its high computing capability, a single V850 can perform the workloads of two or more 16-bit microcontrollers, reducing the number of components, and reducing the total cost.

High-performance RTC (real-time counter)[Note]
Alleviates the software load and further reduces power consumption.

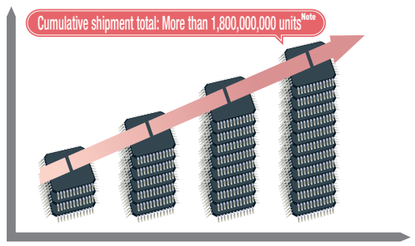
- No need for updating using a program because the RTC has a calendar feature for automatic updating until 2099.
- Sustained clock operation without wakeup to reduce power consumption.
- Built-in alarm starts the microcontroller at the set time (day, hour, minute).



Note Available in some V850ES/Jx3-L products as well as V850ES/Jx3-U and V850ES/Jx3-H products.

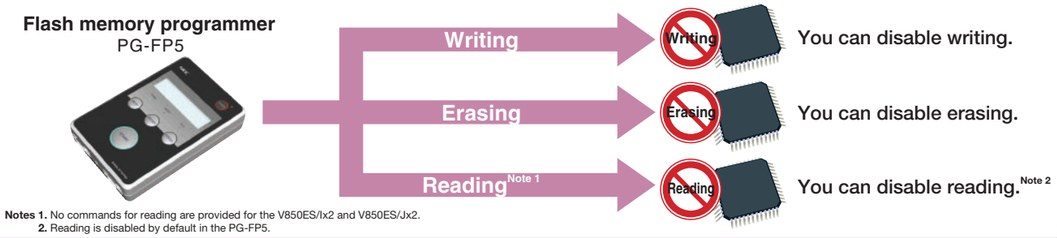
High reliability

The reliability technologies developed for automotive flash microcontrollers can be found in all our flash microcontrollers, making them a safe choice.



Note As of February, 2010

A flash security setting is provided to protect your software from malicious rewriting and reading.

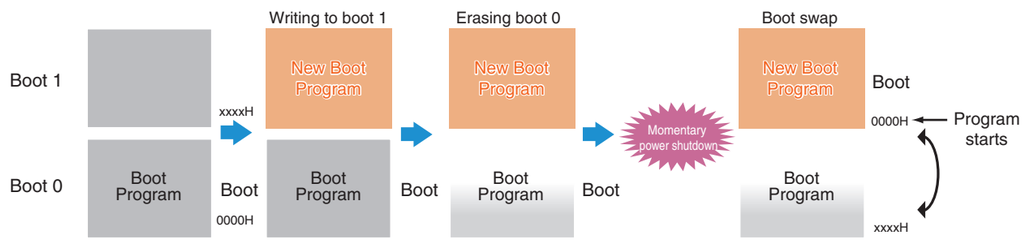


Notes 1. No commands for reading are provided for the V850ES/Ix2 and V850ES/Jx2.
2. Reading is disabled by default in the PG-FP5.

A boot swap feature is provided to protect important programs even when power shuts down during self-programming.

Problems during self-programming

Boot swapping Note



The microcontroller can start normally even when momentary power shutdown occurs during boot rewriting.

Note Supported by the μPD70F3701 in the V850ES/HE2 series, the μPD70F3703 and 70F3704 in the V850ES/HF2 series, and the μPD70F3713 in the V850ES/IE2 series.

Supportive environment for development (1/2)

Renesas Electronics provides a range of development environments for each development phase.

Lineup of development environment

Test board

Target board for MINICUBE2

(Image shows QB-V850ESHG2-TB.)

QB-V850ESHG2-TB, QB-V850ESIE2-TB, QB-V850ESJG2-TB, QB-V850ESKG2-TB, QB-V850ESHG3-TB, QB-V850EIG3-TB, QB-V850ESJG3L-TB, QB-V850ESJJ3-TB, QB-V850ESJG3U-TB, QB-V850EIH4H-TB

Starter kit
Made by TESSERA Technology Inc.

(Image shows TK-850/HG2.)

TK-850/HG2, TK-850/JG2, TK-850/KJ2, TK-850/HG3, TK-850/JG3L, TK-850/JG3, TK-850/JG3H, TK-850/JH3U-SP

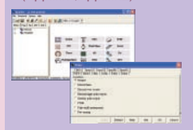
Remark Evaluation boards for Ethernet® and ZigBee® are available.

Software development → **Debugging/verification** → **Writing**

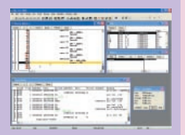
Development environment

Microcontroller integrated development platform (CubeSuite)

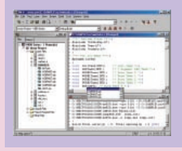
Device driver configurator (Applilet®,Applilet2)



Simulator (SM+)



Compiler/ project manager/ real-time OS (CA850/PM+/RX850/RX850 Pro/RX850V4)



On-chip debug emulator (MINICUBE®) Note 1

Full-function in-circuit emulator (IECUBE)

On-chip debug emulator with programming capability (MINICUBE2)

MINICUBE2 wireless option (QB-MINI2-RF)

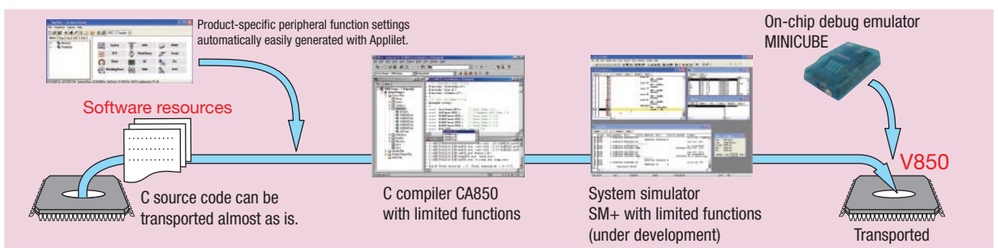
Flash memory programmer (PG-FP5)

Flash memory programmer (FL-PR5)

Note 2

Notes 1. On-chip emulation of the V850ES/KE2, V850ES/KF2, and V850ES/KG2 using MINICUBE is not possible.
2. Products of Naito Densei Machida Mfg. Co., Ltd.

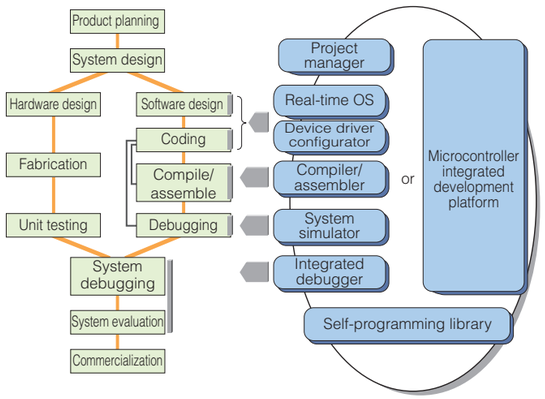
Significant man-hours are required to develop and modify software from existing chips. We have development environments to help reduce these man-hours.



Supportive environment for development (2/2)

Software

• Rich lineup of tools for each development phase



Type	Name
Microcontroller integrated development platform	CubeSuite
Software package	SP850
Project manager	PM+
C compiler	CA850
System simulator	SM+ for V850ES/Hx2
Integrated debugger	ID850QB
Real-time OS	RX850, RX850 Pro, RX850V4[Note]
Self-programming library	Self Lib
Device driver configurator	Applilet for V850ES/Hx2, Jx2, Kx2 Applilet2 for V850ES/Jx3

■ **Microcontroller integrated development platform**
Can be used to compile and debug programs, manage pin layouts, generate code for microcontroller peripherals, and execute high-speed building.

■ **Software package**
Project manager, C compiler, assembler, integrated debugger, etc., provided on a single CD-ROM disk

■ **Project manager**
- Various development tools integrated on Windows™
- A series of operations, such as editor, builder, and debugger startup, is possible.

■ **C compiler**
- ANSI-C standard compliant
- Powerful optimization
- Optimum features for embedded system development
- Multiple utilities

■ **System simulator**
- GUI design similar to that of integrated debugger
- Evaluation possible without target prior to target completion

■ **Integrated debugger**
- Operates on Windows
- Easy to understand GUI
- Buttons provided for frequently used commands
- Can be started up with a simple mouse click

■ **Real-time OS**
- μITRON specification compliant
- Compact size
- Easy program reuse and maintenance

■ **Self-programming library**
- The flash memory can be programmed with the microcontroller itself, without using a programmer.
- Built-in boot swap function for protecting the boot area at power down

■ **Device driver configurator**
The setting sources of the built-in peripheral functions can be automatically generated through GUI operation without referring to the device's user's manual.

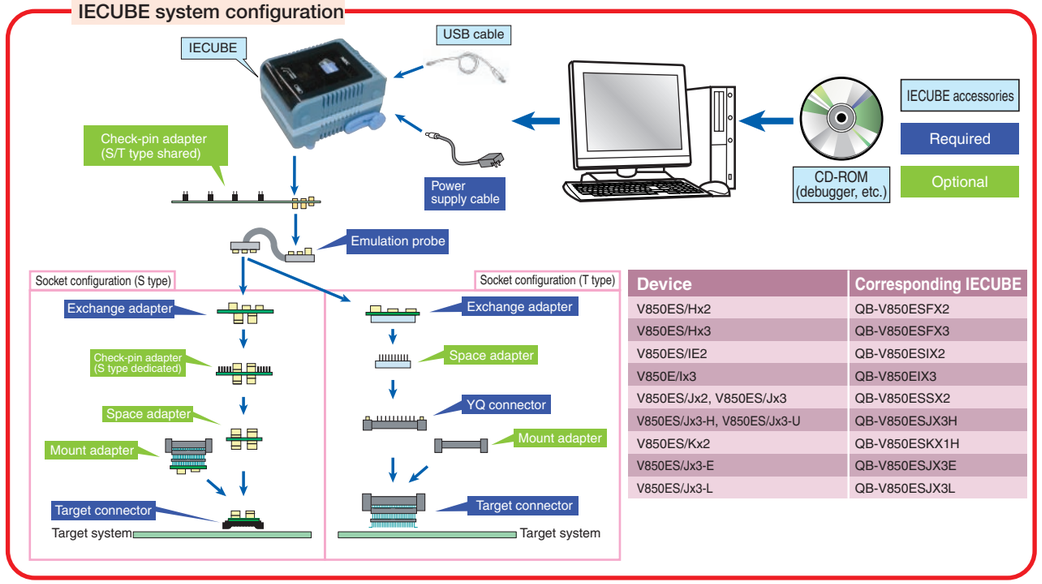
Note Conforms to μITRON 4.0 specifications.

Hardware (1/2)

■ Full-function in-circuit emulator (IECUBE)

• Enables detailed debugging through equivalent emulation of microcontrollers, using trace, time measurement, and other functions.

IECUBE system configuration



Device	Corresponding IECUBE
V850ES/Hx2	QB-V850ESFX2
V850ES/Hx3	QB-V850ESFX3
V850ES/IE2	QB-V850ESIX2
V850E/Ix3	QB-V850EIX3
V850ES/Jx2, V850ES/Jx3	QB-V850ESSX2
V850ES/Jx3-H, V850ES/Jx3-U	QB-V850ESJX3H
V850ES/Kx2	QB-V850ESKX1H
V850ES/Jx3-E	QB-V850ESJX3E
V850ES/Jx3-L	QB-V850ESJX3L

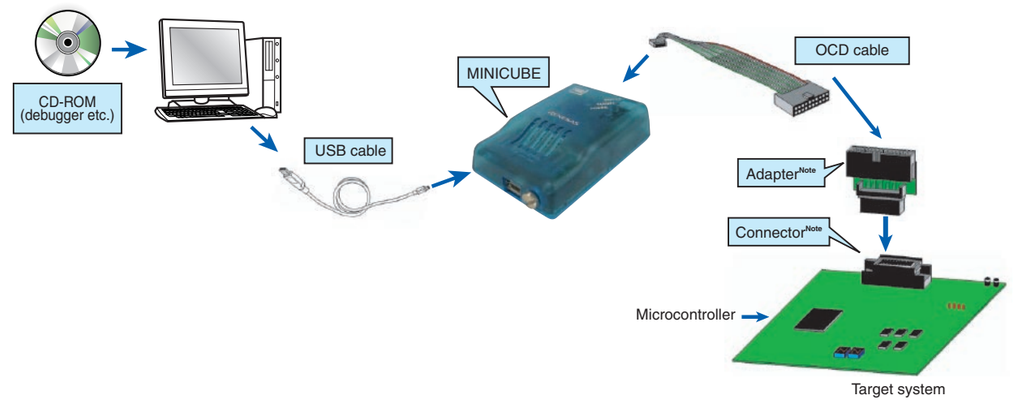
To order development tools, contact a Renesas Electronics sales representative or an authorized Renesas Electronics distributor.

Hardware (2/2)

■ On-chip debug emulator (MINICUBE)

• Debugging with the microcontroller mounted on the target system is possible.
• Basic debugging functions such as run, break, and download are provided.

MINICUBE system configuration



Note The adapter and connector can be selected and purchased from various partners' products according to the mounting area of the target system.
Remark For more information on MINICUBE: http://www2.renesas.com/micro/en/development/asia/v850/minicube.html

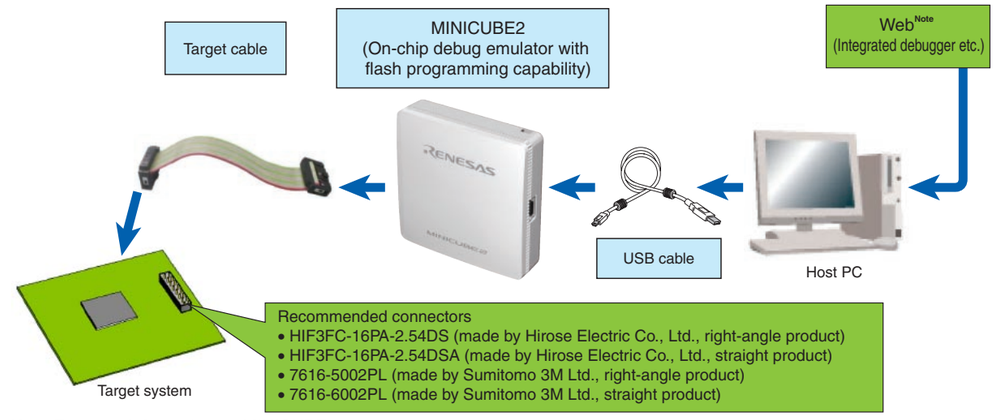
MINICUBE supported devices

V850ES/Hx2, V850ES/Hx3, V850E/IG3, V850ES/Jx2, V850ES/Jx3, V850ES/KJ2, V850ES/Jx3-L (under development), V850ES/Jx3-H, V850ES/Jx3-U, V850ES/Jx3-E, V850E/Ix4, V850E/Ix4-H

■ On-chip debug emulator with flash programming capability (MINICUBE2)

• Debugging with the microcontroller mounted on the target system is possible.
• In addition to simple debugging with a foreground monitor, use as a programmer is also possible.

MINICUBE2 system configuration


Target cable
MINICUBE2 (On-chip debug emulator with flash programming capability)
Web[Note] (Integrated debugger etc.)
USB cable
Host PC
Target system
Recommended connectors
• HIF3FC-16PA-2.54DS (made by Hirose Electric Co., Ltd., right-angle product)
• HIF3FC-16PA-2.54DSA (made by Hirose Electric Co., Ltd., straight product)
• 7616-5002PL (made by Sumitomo 3M Ltd., right-angle product)
• 7616-6002PL (made by Sumitomo 3M Ltd., straight product)

Note For more information on MINICUBE2:
http://www2.renesas.com/micro/en/development/asia/minicube2/minicube2.html

MINICUBE2 accessories

MINICUBE2 supported devices

All devices

To order development tools, contact a Renesas Electronics sales representative or an authorized Renesas Electronics distributor.

Support for mass production

We provide a mass production environment that meets your needs.
You can select the best mass production method for you, based on delivery time or mass production quantity.

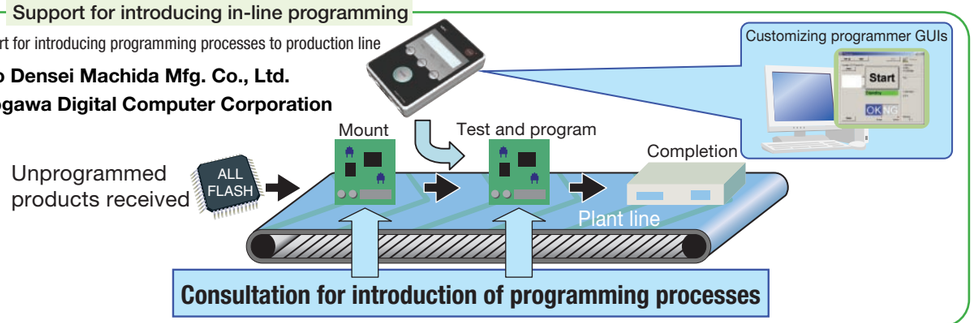
Programming by the customer

Delivery time[Note 1]: Practically none, highly flexible

Support for introducing in-line programming

Support for introducing programming processes to production line

Naito Densei Machida Mfg. Co., Ltd.
Yokogawa Digital Computer Corporation



Flash memory programmers

Various products selectable for your purpose and price range

PG-FP5	FL-PR5	NET IMPRESS series[Note]	Y3000-8[Note]	ITF-2000[Note]	Stick GANG Writer[Note]	StickWriter[Note]
Renesas Electronics	Naito Densei Machida Mfg. Co., Ltd.	Yokogawa Digital Computer Corporation	Wave Technology Co., Ltd.	Interface Co., Ltd.	TESSERA Technology Inc.	TESSERA Technology Inc.

Note Compatibilities differ according to the product.

Programming by partner companies

Flexible support for small-volume programming and short delivery time

Programming houses

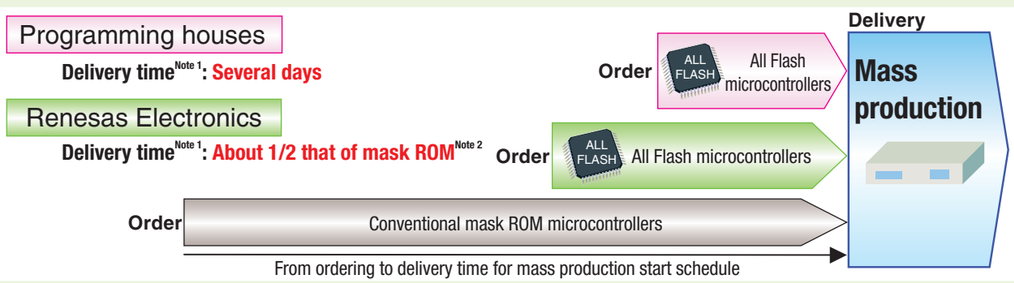
Ask us about the programming houses in your region.

Programmed products

Shipment form same as that of mask ROM microcontrollers

Renesas Electronics

The same way as mask ROM microcontrollers, programmed products can be delivered with a short TAT.



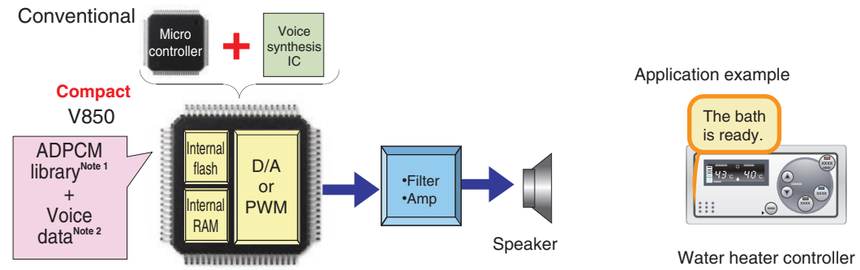
Notes 1. Period from completion of software until start of mass production
2. Delivery time may vary depending on purchase conditions, such as order quantity.

Application examples

You can achieve the functionality you need by combining V850 All Flash features and libraries.
New features can be easily constructed. One example is introduced below.

Speaking (ADPCM: Adaptive Differential Pulse Code Modulation)

System control and voice feature now on one chip, contributing to reduced costs.



Note 1. ADPCM library (ADPCM-SP) features

Library size		Processing performance (at 20 MHz)	
ROM	RAM	Compression	Decompression
3 KB	32 bytes	15 µs, max.	12 µs, max.

Cautions 1. The above processing times are processing times for individual libraries. When mounted in a system, extra processing time is required for output processing.
2. Processing is necessary every 125 µs in the case of 8 kHz sampling voice.

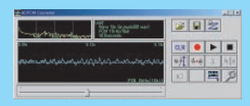
Note 2. Voice data compression can be chosen from 3 patterns.

Compression rate	High audio quality ← → High compression		
	4 KBps	3 KBps	2 KBps

Evaluation environment to support "speaking"

CEB-V850ES/JG2
Made by COSMO Co., Ltd.

Voice conversion tool (WAVE→ADPCM)

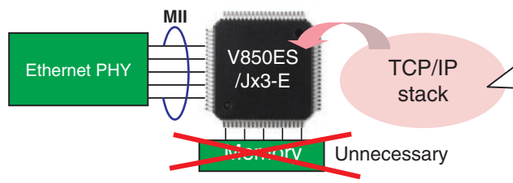


CvADPCM
Made by Renesas Electronics
Obtained from our website

Connecting (TCP/IP)

The high-performance V850ES/Jx3-E has a large-capacity internal memory, enabling single-chip control of networks and systems.

"Connecting" achieved with a simple structure not requiring external memory



Middleware to support "connecting"

The TCP-IP protocol stacks available from our experienced partner companies provide powerful support.

- **USNetPlus** (Nissin Systems Co., Ltd.)
- **Qlism** (NEC Communication Systems)
- **kasago** (Zuken Elmic, Inc.)
- **Cente** (Data Technology Inc.)
- **Ubiquitous TCP-IP** (Ubiquitous Corporation)

Renesas Electronics also provides a library for evaluation.

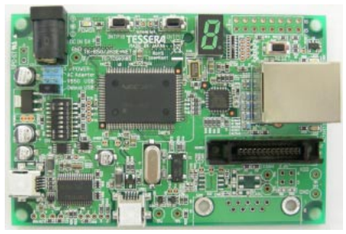
- **Compact TCP-IP stack**

"Connecting" system example

Renesas Electronics microcontrollers can be used for "connecting" in factory automation networks, building management systems, and many other applications.

Evaluation kit to support "connecting"

TK-850/JH3E+NET
(Incorporated in the V850ES/JH3-E)



Manufactured by TESSERA Technology Inc.[Note]

Note Please check when sales will begin.

Product specifications (1/4)

Generic Name			V850ES/HE2		V850ES/HF2			V850ES/HG2		V850ES/HJ2				V850ES/HE3	V850ES/HF3	V850ES/HG3	V850ES/HJ3		V850ES/IE2		V850E/IF3		V850E/IG3		V850E/IG4			V850E/IH4			V850E/IG4-H			V850E/IH4-H		
Pin Count			64-pin		80-pin			100-pin		144-pin				64-pin	80-pin	100-pin	144-pin		64-pin		80-pin		100-pin	100-/161-pin	100-pin			128-pin			100-pin			128-pin		
Part Number			μPD70F3700	μPD70F3701	μPD70F3702	μPD70F3703	μPD70F3704	μPD70F3706	μPD70F3707	μPD70F3709	μPD70F3710	μPD70F3711	μPD70F3712		μPD70F3747	μPD70F3750	μPD70F3752	μPD70F3755	μPD70F3757	μPD70F3713	μPD70F3714	μPD70F3451	μPD70F3452	μPD70F3453	μPD70F3454	μPD70F3913	μPD70F3914	μPD70F3915	μPD70F3916	μPD70F3917	μPD70F3918	μPD70F3919	μPD70F3920	μPD70F3921	μPD70F3922	μPD70F3923	μPD70F3924
CPU core			V850ES core		V850ES core			V850ES core		V850ES core				V850ES core	V850ES core	V850ES core	V850ES core		V850ES core		V850E core		V850E core		V850E core			V850E core			V850E core			V850E core		
CPU performance (Dhrystone)			43MIPS (@ 20 MHz)		43MIPS (@ 20 MHz)			43MIPS (@ 20 MHz)		43MIPS (@ 20 MHz)				69MIPS		(@ 32 MHz)		56MIPS (@ 32 MHz)	39MIPS (@ 20 MHz)		131MIPS (@ 64 MHz)		131MIPS (@ 64 MHz)		197MIPS (@ 100 MHz)			197MIPS (@ 100 MHz)			197MIPS (@ 100 MHz)			197MIPS (@ 100 MHz)		
Flash memory (bytes)			64 K	128 K	64 K	128 K	256 K	128 K	256 K	128 K	256 K	376 K	512 K		128 K	256 K	256 K	256 K	512 K	64 K	128 K	128 K	256 K	128 K	256 K	256K	384 K	480 K	256K	384 K	480 K	256K	384 K	480 K	256K	384 K	480 K
RAM (bytes)			6 K	6 K	12 K	12 K	12 K	12 K	12 K	12 K	12 K	20 K	20 K		8 K	16 K	16 K	16 K	32 K	6 K	6 K	8 K	12 K	8 K	12 K	24 K	24 K	24 K	24 K	24 K	24 K	24 K	24 K	24 K	24 K	24 K	24 K
External bus interface	Bus type		–		–			–		Multiplexed				–	–	–	Multiplexed		–		–		–	Notes 1, 2	–			–			Multiplexed[Note 3]			Separate/Multiplexed		
	Address bus		–		–			–		16				–	–	–	16		–		–		–	8/16[Note 2]	–			–			16			Multiplexed:16 bits, Separate:8 bits		
	Data bus		–		–			–		8/16				–	–	–	8/16		–		–		–	8/16[Note 2]	–			–			8/16			8/16		
	Chip select signal		–		–			–		4				–	–	–	4		–		–		–	2[Note 2]	–			–			2			2		
Power supply voltage			3.5 to 5.5 V (A/D converter: 4.0 to 5.5 V)											3.7 to 5.5 V (A/D		converter: 4.0 to 5.5 V)			3.5 to 5.5 V (A/D converter: 4.5 to 5.5 V)		3.5 to 5.5 V (A/D converter: 4.0 to 5.5 V)				1.5 V/5.0 V			1.5 V/5.0 V			1.5 V/5.0 V/3.3 V			1.5 V/5.0 V/3.3 V		
Clock	Main clock		4 to 20 MHz		4 to 20 MHz			4 to 20 MHz		4 to 20 MHz						4 to 32 MHz			20 MHz		4 to 64 MHz		4 to 64 MHz		10 to 12.5 MHz			10 to 12.5 MHz			10 to 12.5 MHz			10 to 12.5 MHz		
	Subclock (crystal resonator)		32.768 kHz		32.768 kHz			32.768 kHz		32.768 kHz						32.768 kHz			–		–		–		–			–			–			–		
	Internal oscillation clock		200 kHz (TYP.)		200 kHz (TYP.)			200 kHz (TYP.)		200 kHz (TYP.)						240 kHz/8 MHz (TYP.)			–		–		–		–			–			–			–		
Port	I/O		51		67			84		128				51	67	84	128		39		44		56		55			68			51			68		
	Input		–		–			–		–				–	–	–	–		–		4		8		12			12			12			12		
Timer/counter	16-bit timer (TMQ/TAB)	Number of channels	1		1			2		3				1	1	2	3		2		2		2		2			2			2			2		
		Function	Interval timer/external event counter/PWM output (3 channels max.) /pulse width measurement/square-wave output/one-shot pulse output																																		
	16-bit timer (TMP/TAA)	Number of channels	4		4			4		4				5	5	5	5		4		5		5		3			3			3			3		
		Function	Interval timer/external event counter/PWM output/pulse width measurement/square-wave output/one-shot pulse output																																		
	16-bit timer (TMT)	Number of channels	–		–			–		–				–	–	–	–		–		2		2		4			4			4			4		
		Function	–		–			–		–				–	–	–	–		–		Interval timer/external event counter/PWM output/ pulse width measurement/square-wave output/ one-shot pulse output/encoder counter																
	16-bit timer (TMM)	Number of channels	1		1			1		1				1	1	1	1		1		4		4		4			4			4			4		
		Function	Interval timer																																		
	Watch timer		1		1			1		1				1	1	1	1		–		–		–		–			–			–			–		
	Real-time counter (RTC)		–		–			–		–				–	–	–	–		–		–		–		–			–			–			–		
	Watchdog timer (WDT)		1		1			1		1				1	1	1	1		1		1		1		1			1			1			1		
Serial interface	CSI		2		2			2		3				2	2	2	3	1	1		–		–		–			–			–			–		
	CSI with automatic transmit/receive functions (32-byte buffer)		–		–			–		–				–	–	–	–		–		–		–		–			–			–			–		
	UART		2[Note 4]		2[Note 4]			3[Note 4]		3[Note 4]			4[Note 4]	2[Note 4]	2[Note 4]	3[Note 4]	3[Note 4]	4[Notes 4, 5]	2		–		–		–			–			–			–		
	I^2C		–		–			–		–				1	1	1	1	–	–		–		–		–			–			–			–		
	UART/CSI		–		–			–		–				–	–	–	–	2[Notes 4, 5]	–		3[Note 6]		3[Note 6]		3[Note 6]			3[Note 6]			3[Note 6]			3[Note 6]		
	UART/I^2C		–		–			–		–				–	–	–	–	1[Note 4]	–		1		1		1			1			1			1		
	CSI/I^2C		–		–			–		–				–	–	–	–		–		–		–		–			–			–			–		
	UART/CSI/I^2C		–		–			–		–				–	–	–	–		–		–		–		–			–			–			1		
	UART/I^2C/CAN		–		–			–		–				–	–	–	–		–		–		–		–			–			–			–		
USB controller	USB2.0 function		–		–			–		–				–	–	–	–		–		–		–		–			–			1 (full-speed)			1 (full-speed)		
	USB2.0 host		–		–			–		–				–	–	–	–		–		–		–		–			–			–			–		
Ethernet controller			–		–			–		–				–	–	–	–		–		–		–		–			–			–			–		
A/D converter	12-bit		–		–			–		–				–	–	–	–		–		5 × 2 units		5 × 2 units		(4, 3) × 1 units			4 × 2 units			(4, 3) × 1 units			4 × 2 units		
	10-bit		10		12			16		24				10	12	16	24		4 × 2 units		4		8		12			12			12			12		
D/A converter (8-bit)			–		–			–		–				–	–	–	–		–		–		–		–			–			–			–		
DMA controller			–		–			4[Note 7]		4[Note 8]				4[Note 7]	4[Note 7]	4[Note 7]	4[Note 8]		–		4[Note 7]		4[Note 7]		7			7			7			7		
Interrupt source	External		9		9			12		16				9	9	12	16		7		15		21		22			22			22			22		
	Internal		32		32			43		50			52	43	43	51	58	64	36		74		75		82			82			84			84		
On-chip debug function	MINICUBE		Provided		Provided			Provided		Provided				Provided	Provided	Provided	Provided		–		–		Provided		Provided			Provided			Provided			Provided		
	MINICUBE2		Provided		Provided			Provided		Provided				Provided	Provided	Provided	Provided		Provided		Provided		Provided		Provided			Provided			Provided			Provided		
Other peripheral I/O functions			On-chip POC/LVI, clock monitor, RAM hold flag											Motor control Hi-Z output on-chip clock RAM hold		(1 ch), control, POC/LVI, monitor, flag, SSCG			Motor control (1 ch), Hi-Z output control, on-chip POC/LVI, RAM hold flag, clock monitor		Motor control (2 ch), Hi-Z output control, on-chip POC/LVI, operational amplifier, comparator, clock monitor				Motor control (2 ch), Hi-Z output control, operational amplifier (6 ch), comparator, on-chip POC/LVI, clock monitor						Motor control (2 ch), Hi-Z output control, operational amplifier (6 ch), comparator, on-chip POC/LVI, clock monitor					
Operating ambient temperature			–40 to +85°C											–40 to		+85°C			–40 to +85°C		–40 to +85°C				–40 to +85°C						–40 to +85°C					

Notes 1. Separate/Multiplexed (interface voltage: 5 V) **2.** Provided only in the GC package products. **3.** Interface voltage: 5 V **4.** UART supports LIN. **5.** This UART is shared by a port or both CSI and a port. Six UART channels are provided in the μPD70F3757. **6.** FIFO buffer provided for UART in one of these channels. **7.** Transfer to/from on-chip peripherals and internal RAM. **8.** Transfer to/from on-chip peripherals, internal RAM, and external memory.

Product specifications (2/4)

Generic Name			V850ES/JG2					V850ES/JJ2					V850ES/JC3-L Note 1								V850ES/JE3-L Note 1				V850ES/JF3-L		V850ES /JG3-L						V850ES/JG3				V850ES/JJ3			
Pin Count			100-pin					144-pin					40-pin				48-pin				64-pin				80-pin		100/121-pin						100-pin				144-pin			
Part Number			μPD70F3715	μPD70F3716	μPD70F3717	μPD70F3718	μPD70F3719	μPD70F3720	μPD70F3721	μPD70F3722	μPD70F3723	μPD70F3724	μPD70F3797	μPD70F3798	μPD70F3799	μPD70F3800	μPD70F3801	μPD70F3802	μPD70F3803	μPD70F3804	μPD70F3805	μPD70F3806	μPD70F3807	μPD70F3808	μPD70F3735	μPD70F3736	μPD70F3737	μPD70F3738	μPD70F3792 Note 1	μPD70F3793 Note 1	μPD70F3794 Note 1	μPD70F3795 Note 1	μPD70F3796 Note 1	μPD70F3739	μPD70F3740	μPD70F3741	μPD70F3742	μPD70F3743	μPD70F3744	μPD70F3745	μPD70F3746
CPU core			V850ES core					V850ES core					V850ES core								V850ES core				V850ES core		V850ES core						V850ES core				V850ES core			
CPU performance (Dhrystone)			43MIPS (@ 20 MHz)					43MIPS (@ 20 MHz)					43MIPS (@ 20 MHz)								43MIPS (@ 20 MHz)				43MIPS (@ 20 MHz)		43MIPS (@ 20 MHz)						69MIPS (@ 32 MHz)				69MIPS (@ 32 MHz)			
Flash memory (bytes)			128 K	256 K	384 K	512 K	640 K	128 K	256 K	384 K	512 K	640 K	16 K	32 K	64 K	128 K	16 K	32 K	64 K	128 K	16 K	32 K	64 K	128 K	128 K	256 K	128 K	256 K	384 K	512 K	256 K	384 K	512 K	384 K	512 K	768 K	1024 K	384 K	512 K	768 K	1024 K
RAM (bytes)			12 K	24 K	32 K	40 K	48 K	12 K	24 K	32 K	40 K	48 K	8 K	8 K	8 K	8 K	8 K	8 K	8 K	8 K	8 K	8 K	8 K	8 K	8 K	16 K	8 K	16 K	32 K	40 K	40 K	40 K	40 K	32 K	40 K	60 K	60 K	32 K	40 K	60 K	60 K
External bus interface	Bus type		Separate/Multiplexed					Separate/Multiplexed					–				–				–				Multiplexed		Separate/Multiplexed						Separate/Multiplexed				Separate/Multiplexed			
	Address bus		22					24					–				–				–				18		22						22				24			
	Data bus		8/16					8/16					–				–				–				8/16		8/16						8/16				8/16			
	Chip select signal		–					4					–				–				–				–		–						–				4			
Power supply voltage			2.85 to 3.6 V (A/D converter: 3.0 to 3.6 V)										2.2 to 3.6 V (A/D converter: 2.7 to 3.6 V)																2.0 to 3.6 V (A/D converter: 2.7 to 3.6 V)		2.0 to 3.6 V (USB operation: 3.0 to 3.6 V, A/D converter: 2.7 to 3.6 V)				2.85 to 3.6 V (A/D converter: 3.0 to 3.6 V)							
Clock	Main clock		2.5 to 20 MHz					2.5 to 20 MHz					2.5 to 20 MHz				2.5 to 20 MHz				2.5 to 20 MHz				2.5 to 20 MHz		2.5 to 20 MHz					2.5 to 20 MHz, 2.5 to 16 MHz (USB operation)	2.5 to 32 MHz				2.5 to 32 MHz			
	Subclock (crystal resonator)		32.768 kHz					32.768 kHz					32.768 kHz				32.768 kHz				32.768 kHz				32.768 kHz		32.768 kHz						32.768 kHz				32.768 kHz			
	Internal oscillation clock		200 kHz (TYP.)					200 kHz (TYP.)					220 kHz (TYP.)				220 kHz (TYP.)				220 kHz (TYP.)				220 kHz (TYP.)		220 kHz (TYP.)						220 kHz (TYP.)				220 kHz (TYP.)			
Port	I/O		84 (of which 5 V tolerance: 40)					128 (of which 5 V tolerance: 60)					27 (of which 5 V tolerance: 17)				34 (of which 5 V tolerance: 20)				50 (of which 5 V tolerance: 28)				66 (of which 5 V tolerance: 25)		84 (of which 5 V tolerance: 31)		83 (of which 5 V tolerance: 31)		80 (of which 5 V tolerance: 28)		84 (of which 5 V tolerance: 40)				128 (of which 5 V tolerance: 60)			
	Input		–					–					–				–				–				–		–						–				–			
Timer/counter	16-bit timer (TMQ/TAB)	Number of channels	1					1					1				1				1				1		1						1				1			
		Function	Interval timer/external event counter /PWM output (3 channels max.)/pulse width measurement/square-wave output/one-shot pulse output																																							
	16-bit timer (TMP/TAA)	Number of channels	6					9					6				6				6				4		6						6				9			
		Function	Interval timer/external event counter /PWM output/pulse width measurement/square-wave output/one-shot pulse output																																							
	16-bit timer (TMT)	Number of channels	–					–					–				–				–				–		–						–				–			
		Function	–					–					–				–				–				–		–						–				–			
	16-bit timer (TMM)	Number of channels	1					1					1				1				1				1		1						1				1			
		Function	Interval timer																																							
	Watch timer		1					1					1				1				1				1		1						1				1			
	Real-time counter (RTC)		–					–					–				–				–				–		–	1					–				–			
	Watchdog timer (WDT)		1					1					1				1				1				1		1						1				1			
Serial interface	CSI		3					4					1				2				3				2		3						3				4			
	CSI with automatic transmit/receive functions (32-byte buffer)		–					–					–				–				–				–		–						–				–			
	UART		–					1 Note 2					1 Note 2				–				–				2 Note 2		–	4 Note 2					–				1 Note 2			
	I^2C		–					–					–				–				–				–		–						–				–			
	UART/CSI		1 Note 2					1 Note 2					–				1 Note 2				1 Note 2				–		1 Note 2						1 Note 2				1 Note 2			
	UART/I^2C		2 Note 2					2 Note 2					1 Note 2				2 Note 2				2 Note 2				1 Note 2		2 Note 2						2 Note 2				2 Note 2			
	CSI/I^2C		1					1					1				1				1				1		1						1				1			
	UART/CSI/I^2C		–					–					–				–				–				–		–						–				–			
	UART/I^2C/CAN		–					–					–				–				–				–		–						–				–			
USB controller	USB2.0 function		–					–					–				–				–				–		–				1 (full-speed)		–				–			
	USB2.0 host		–					–					–				–				–				–		–						–				–			
Ethernet controller			–					–					–				–				–				–		–						–				–			
A/D converter	12-bit		–					–					–				–				–				-		–						–				–			
	10-bit		12					16					5				6				10				8		12						12				16			
D/A converter (8-bit)			2					2					–				1				1				1		2						2				2			
DMA controller			4 Note 3					4 Note 3					4 Note 3				4 Note 3				4 Note 3				4 Note 3		4 Note 3						4 Note 3				4 Note 3			
Interrupt source	External		9					10					6				6				9				9		9						9				10			
	Internal		48					61					43				47				49				40		48	55					48				61			
On-chip debug function	MINICUBE		Provided					Provided					Provided				Provided				Provided				Provided		Provided						Provided				Provided			
	MINICUBE2		Provided					Provided					Provided				Provided				Provided				Provided		Provided						Provided				Provided			
Other peripheral I/O functions			On-chip LVI, clock monitor, real-time output										On-chip LVI, clock monitor, real-time output, CRC																				On-chip LVI, clock monitor, real-time output, CRC							
Operating ambient temperature			–40 to +85°C										–40 to +85 °C																				–40 to +85°C							

Notes 1. Under development. **2.** UART supports LIN. **3.** Transfer to/from on-chip peripherals, internal RAM, and external memory.

Product specifications (3/4)

Generic Name			V850ES/JC3-H Note 1										V850ES/JE3-H Note 1						V850ES/ JG3-H				V850ES/JH3-H				V850ES/JG3-U		V850ES/JH3-U		V850ES/JE3-E Note 1				V850ES/JF3-E Note 1				V850ES/JG3-E Note 1				V850ES/JH3-E				V850ES/JJ3-E			
Pin Count			40-pin					48-pin					64-pin						100 -pin				128-pin				100-pin		128-pin		64-pin				80-pin				100/113-pin				128-pin				144-pin			
Part Number			µPD70F3809	µPD70F3810	µPD70F3811	µPD70F3812	µPD70F3813	µPD70F3814	µPD70F3815	µPD70F3816	µPD70F3817	µPD70F3818	µPD70F3819	µPD70F3820	µPD70F3821	µPD70F3822	µPD70F3823	µPD70F3824	µPD70F3825	µPD70F3760	µPD70F3761	µPD70F3762	µPD70F3770	µPD70F3765	µPD70F3766	µPD70F3767	µPD70F3771	µPD70F3763	µPD70F3764	µPD70F3768	µPD70F3769	µPD70F3826	µPD70F3827	µPD70F3828	µPD70F3829	µPD70F3830	µPD70F3831	µPD70F3832	µPD70F3833	µPD70F3834	µPD70F3835	µPD70F3836	µPD70F3837	µPD70F3778	µPD70F3779	µPD70F3780	µPD70F3781	µPD70F3782	µPD70F3783	µPD70F3784	µPD70F3785	µPD70F3786
CPU core			V850ES core										V850ES core						V850ES core				V850ES core				V850ES core		V850ES core																					
CPU performance (Dhrystone)			98MIPS (@ 48 MHz)										98MIPS (@ 48 MHz)						98MIPS (@ 48 MHz)				98MIPS (@ 48 MHz)				98MIPS (@ 48 MHz)		98MIPS (@ 48 MHz)		103MIPS (@ 50 MHz)				103MIPS (@ 50 MHz)				103MIPS (@ 50 MHz)				103MIPS (@ 50 MHz)				103MIPS (@ 48 MHz)			
Flash memory (bytes)			16 K	32 K	64 K	128 K	256 K	16 K	32 K	64 K	128 K	256 K	256 K	16 K	32 K	64 K	128 K	256 K	256 K	256 K	384 K	51 2 K	256 K	256 K	384 K	512 K	256 K	384 K	512 K	384 K	512 K	64 K	128 K	256 K	256 K	64 K	128 K	256 K	256 K	64 K	128 K	256 K	256 K	256 K	384 K	512 K	384 K	512 K	512 K	512 K	512 K
RAM (bytes)			8 K	16 K	24 K	24 K	24 K	8 K	16 K	24 K	24 K	24 K	24 K	8 K	16 K	24 K	24 K	24 K	24 K	40 K Note 2	48 K Note 2	56 K Note 2	40 K Note 2	40 K Note 2	48 K Note 2	56 K Note 2	40 K Note 2	48 K Note 2	56 K Note 2	48 K Note 2	56 K Note 2	32 K Note 3	48 K Note 3	64 K Note 3	64 K Note 3	32 K Note 3	48 K Note 3	64 K Note 3	64 K Note 3	32 K Note 3	48 K Note 3	64 K Note 3	64 K Note 3	76 K Note 3	76 K Note 3	76 K Note 3	124 K Note 4	124 K Note 4	124 K Note 4	76 K Note 3	124 K Note 4	124 K Note 4
External bus interface	Bus type		–					–					–						Multiplexed				Separate/Multiplexed				Multiplexed		Separate/Multiplexed		–				–				–				Separate/Multiplexed								Separate/Multiplexed		
	Address bus		–					–					–						16				24				16		24		–				–				–				22								24		
	Data bus		–					–					–						8/16				8/16				8/16		8/16		–				–				–				8/16								8/16		
	Chip select signal		–					–					–						3				3				3		3		–				–				–				2								3		
Power supply voltage			2.85 to 3.6 V (A/D converter, USB controller: 3.0 to 3.6 V)																								2.85 to 3.6 V (A/D converter, USB controller: 3.0 to 3.6 V)				2.85 to 3.6 V (A/ D converter, USB controller: 3.0 to 3.6 V)																						
Clock	Main clock		24 to 48 MHz					24 to 48 MHz					24 to 48 MHz						24 to 48	MHz			24 to 48 MHz				24 to 48 MHz		24 to 48 MHz		24 to 50 MHz				24 to 50 MHz				24 to 50 MHz				24 to 50 MHz				24 to 50 MHz			
	Subclock (crystal resonator)		32.768 kHz					32.768 kHz					32.768 kHz						32.768	kHz			32.768 kHz				32.768 kHz		32.768 kHz		32.768 kHz				32.768 kHz				32.768 kHz				32.768 kHz				32.768 kHz			
	Internal oscillation clock		220 kHz (TYP.)					220 kHz (TYP.)					220 kHz (TYP.)						220 kHz	(TYP.)			220 kHz (TYP.)				220 kHz (TYP.)		220 kHz (TYP.)		220 kHz (TYP.)				220 kHz (TYP.)				220 kHz (TYP.)				220 kHz (TYP.)				220 kHz (TYP.)			
Port	I/O		25 (of which 5 V tolerance: 13)					32 (of which 5 V tolerance: 15)					45 (of which 5 V tolerance: 18)						77 (of which tolerance:	5 V 24)			96 (of which 5 V tolerance: 27)				75 (of which 5 V tolerance: 22)		96 (of which 5 V tolerance: 27)		29 (of which 5 V tolerance: 14)				41 (of which 5 V tolerance: 19)				64 (of which 5 V tolerance: 28)				84 (of which 5 V tolerance: 48)				100 (of which 5 V tolerance: 59)			
	Input		–					–					–						–				–				–		–		–				–				–				–				–			
Timer/counter	16-bit timer (TMQ/TAB)	Number of channels	1					1					1						2				2				2		2		1				1				1				2				2			
		Function	Interval timer/external event counter/ PWM output (3 channels max.)/pulse width measurement/square-wave output/one-shot pulse output																																																	
	16-bit timer (TMP/TAA)	Number of channels	4					4					4						6				6				6		6		4				4				4				6				6			
		Function	Interval timer/external event counter/PWM output/pulse width measurement/square-wave output/one-shot pulse output																																																
	16-bit timer (TMT)	Number of channels	1					1					1						1				1				1		1		1				1				1				1				1			
		Function	Interval timer, external event counter/ PWM output/pulse width measurement/square-wave output/ one-shot pulse output/encoder counter																																																
	16-bit timer (TMM)	Number of channels	4					4					4						4				4				4		4		4				4				4				4				4			
		Function	Interval timer																																																
	Watch timer		–					–					–						–				–				–		–		–				–				–				–				–			
	Real-time counter (RTC)		1					1					1						1				1				1		1		1				1				1				1				1			
	Watchdog timer (WDT)		1					1					1						1				1				1		1		1				1				1				1				1			
Serial interface	CSI		1					1					1						2				2				2		2		1				2				2				1 Notes 5, 6				1 Notes 5, 6			
	CSI with automatic transmit/receive functions (32-byte buffer)		–					–					–						–				–				–		–		–				–				–				–				–			
	UART		–					–					–						–				–				–		–		–				–				–				–				–			
	I^2C		–					–					–						–				–				–		–		–				–				–				–				1			
	UART/CSI		2 Note 7					2 Note 7					2 Note 7						2 Note 7				2 Note 7				2 Note 7		2 Note 7		1 Note 7				1 Note 7				1 Note 7				4 Notes 6, 7, 8, 9				6 Notes 7, 8, 9			
	UART/I^2C		–					1 Note 7		–			1 Note 7			–			2 Note 7		1 Note 7		2 Note 7			1 Note 7		2 Note 7		1 Note 7		1 Note 7		–		1 Note 7		–		1 Note 7		–		1 Note 7		–		1 Note 7		–	
	CSI/I^2C		–					–					–						–				–				–		–		–				–				–				–				–			
	UART/CSI/I^2C		1 Note 7					1 Note 7					1 Note 7						1 Note 7				1 Note 7				1 Note 7		1 Note 7		1 Note 7				2 Note 7				2 Note 7				3 Notes 5, 6, 7				3 Notes 5, 6, 7			
	UART/I^2C/CAN		–			1 Note 7		–			1 Note 7		–			1 Note 7			–			1 Note 7		–			1 Note 7		–		–			1 Note 7		–			1 Note 7		–			1 Note 7		–			1 Note 7		–			1 Note 7
USB controller	USB2.0 function		1 (full-speed)					1 (full-speed)					1 (full-speed)						1 (full-	speed)			1 (full-speed)				1 (full-speed)		1 (full-speed)		1 (full-speed)				1 (full-speed)				1 (full-speed)				1 (full-speed)				1 (full-speed)			
	USB2.0 host		–					–					–						–				–				1 (full-speed)		1 (full-speed)		–				–				–				–				–			
Ethernet controller			–					–					–						–				–				–		–		1				1				1				1				1			
A/D converter	12-bit		–					–					–						–				–				–		–		–				–				–				–				–			
	10-bit		5					6					10						12				12				12		12		8				8				10				10				12			
D/A converter (8-bit)			–					1					1						2				2				2		2		–				–				–				–				–			
DMA controller			4 Note 10					4 Note 10					4 Note 10						4 Note 10				4 Note 10				4 Note 10		4 Note 10		4 Note 10				4 Note 10				4 Note 10				4 Note 10				4 Note 10			
Interrupt source	External		10					10					11						17				20				15		20		11				20				22				22				27			
	Internal		52					54		58			54			58			69		73		69		73		72		72		62	66			66	67			66	70			78	82			84	88		
On-chip debug function	MINICUBE		Provided					Provided					Provided						Provided				Provided				Provided		Provided		Provided				Provided				Provided				Provided				Provided			
	MINICUBE2		Provided					Provided					Provided						Provided				Provided				Provided		Provided		Provided				Provided				Provided				Provided				Provided			
Other peripheral I/O functions			On-chip LVI, clock monitor, RAM hold flag, real-time output, CRC										On-chip LVI, clock monitor, RAM hold Hi-Z output control, real-time						flag, motor control (1 ch),	output, CRC							On-chip LVI, clock monitor, RAM hold flag, motor control (1 ch), Hi-Z output control, real-time output, CRC				On-chip LVI, clock monitor, RAM hold flag, CRC				On-chip LVI, clock monitor, RAM hold flag, motor control (1 ch), Hi-Z output control, CRC				On-chip LVI, clock monitor, RAM hold flag, motor control (1 ch), Hi-Z output control, real-time output, CRC											
Operating ambient temperature			–40 to +85°C																								–40 to +85°C				–40 to +85°C																			

Notes 1. Under development. **2.** Contains an 8 KB area for data use only. **3.** Contains a 16 KB area for data use only. **4.** Contains a 64 KB area for data use only. **5.** One CSI channel is assigned to two different pins. **6.** One CSI channel includes a FIFO buffer. **7.** UART supports LIN. **8.** One UART/CSI channel is assigned to two different pins. **9.** Two UART channels include a FIFO buffer. **10.** Transfer to/from on-chip peripherals, internal RAM, and external memory.

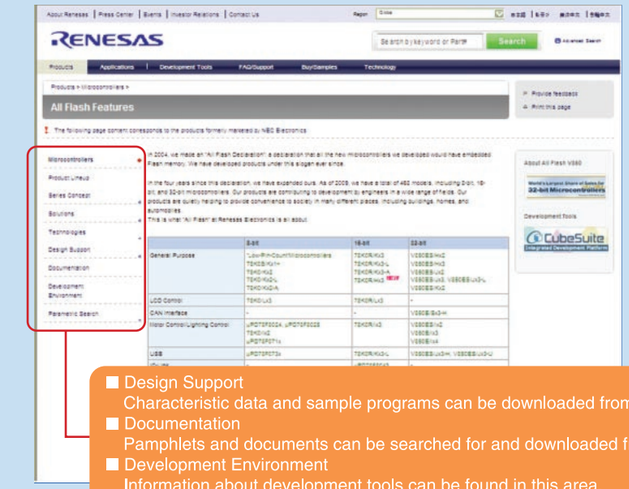
Product specifications (4/4)

Generic Name			V850ES/KE2	V850ES/KF2		V850ES/KG2		V850ES/KJ2	
Pin Count			64-pin	80-pin		100-pin		144-pin	
Part Number			μPD70F3726	μPD70F3728	μPD70F3729	μPD70F3731	μPD70F3732	μPD70F3733	μPD70F3734
CPU core			V850ES core	V850ES core		V850ES core		V850ES core	
CPU performance (Dhrystone)			43MIPS (@ 20 MHz)	43MIPS (@ 20 MHz)		43MIPS (@ 20 MHz)		43MIPS (@ 20 MHz)	
Flash memory (bytes)			128 K	128 K	256 K	128 K	256 K	128 K	256 K
RAM (bytes)			4 K	6 K	12 K	6 K	16 K	6 K	16 K
External bus interface	Bus type		–	Multiplexed		Separate/Multiplexed		Separate/Multiplexed	
	Address bus		–	16		22		24	
	Data bus		–	8/16		8/16		8/16	
	Chip select signal		–	2		2		4	
Power supply voltage			2.7 to 5.5 V	2.7 to 5.5 V		2.7 to 5.5 V		2.7 to 5.5 V	
Clock	Main clock		2 to 20 MHz	2 to 20 MHz		2 to 20 MHz		2 to 20 MHz	
	Subclock (crystal resonator)		32.768 kHz	32.768 kHz		32.768 kHz		32.768 kHz	
	Internal oscillation clock		–	–		–		–	
Port	I/O		43	59		76		112	
	Input		8	8		8		16	
Timer/counter	16-bit timer (TMP/TAA)	Number of channels	1	1		1		1	
		Function	Interval timer/external event counter/PWM output/pulse width measurement/square-wave output/one-shot pulse output						
	16-bit timer (TM0)	Number of channels	1	2		4		6	
		Function	Interval timer/external event counter/PWM output/pulse width measurement/square-wave output/one-shot pulse output						
	8-bit timer (TM5)	Number of channels	2	2		2		2	
		Function	Interval timer/external event counter/PWM output/square-wave output						
	8-bit timer (TMH)	Number of channels	2	2		2		2	
		Function	Interval timer/PWM output/carrier generator output/square-wave output						
	8-bit timer (BRG)	Number of channels	1	1		1		1	
		Function	Interval timer						
	Watch timer		1	1		1		1	
	Real-time counter (RTC)		–	–		–		–	
	Watchdog timer (WDT)		2	2		2		2	
Serial interface	CSI		2	2		1		2	
	CSI with automatic transmit/receive functions (32-byte buffer)		–	1		2		2	
	UART		2	2		2		2	
	I^2C		1	1		1		1	
	UART/CSI		–	–		1		1 Note	
	UART/I^2C		–	–		–		1 Note	
	CSI/I^2C		–	–		–		–	
	UART/CSI/I^2C		–	–		–		–	
	UART/I^2C/CAN		–	–		–		–	
USB controller	USB2.0 function		–	–		–		–	
	USB2.0 host		–	–		–		–	
A/Dconverter	12-bit		–	–		–		–	
	10-bit		8	8		8		16	
D/A converter (8-bit)			–	–		2		2	
DMA controller			–	–		4 (Transfer to/from: on-chip peripherals, internal RAM, external memory)			
Interrupt source	External		9	9		9		9	
	Internal		26	29		41		47	
On-chip debug function	MINICUBE		–	–		–		–	Provided
	MINICUBE2		Provided	Provided		Provided		Provided	
Other peripheral I/O functions			Real-time output	Real-time output		Real-time output		Real-time output	
Operating ambient temperature			–40 to +85°C	–40 to +85°C		–40 to +85°C		–40 to +85°C	

Note This UART is shared by I^2C and CSI. Three UART channels are provided in the V850ES/KJ2.

The Microcontrollers page on the Renesas Electronics website provides a range of information, including All Flash documentation and other contents.

http://www2.renesas.com/micro/en/promotion/allflash/



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http://www.mtbrk.com

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http://www.liberty-rom.com

ROMTEC.Inc
http://www.romtec.co.jp

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http://www.arrowne.com

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Source Electronics Corporation
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http://www.telfordgp.com

Naito Densei Machida Mfg. Co., Ltd.
http://www.ndk-m.co.jp/asmis/eng

Yokogawa Digital Computer Corporation
http://www.yokogawa-digital.com/en

Wave Technology Co., Ltd.
http://www.wavetechnology.co.jp/en/index.html

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http://www.tessera.co.jp/eng/index.html

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http://www.itf.co.jp

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